SPECIAL ARTICLES

SKETCH OF THE GEOLOGIC HISTORY OF THE FLORIDIAN PLATEAU [1]

RECENTLY I have endeavored to bring together the data bearing on the geologic history of the Floridian Plateau, and have an essay in press as one of the Contributions from Tortugas Marine Biological Laboratory of the Carnegie Institution of Washington. A summary of the evidence and conclusions was presented before the Geological Society of Washington, at its meeting on April 27, and a concise statement of the conclusions is given in the succeeding remarks.

The agencies which originally shaped, and subsequently dominated, the development of the plateau were of two kinds: (1) those that caused warpings of the earth's crust; (2) those resulting in the deposition of material on the sea-floor, viz., corrosion and erosion of the land surface above sea-level, transportation to the sea, transportation and deposition of land-derived material in the sea, and organisms which added their skeletal remains to the material of inorganic origin.

The plateau existed in Vicksburgian, lower Oligocene time, forming a projection, as a submarine platform, of the southeastern corner of the continental shelf and extending at least to its present southern limit. This older Oligocene platform was due to a fold of the ocean bottom, perhaps in some way connected with the angle of the Piedmont area in central Georgia. During this period the water over this plateau was shallow, perhaps in no place 100 fathoms deep; the bottom temperature was between 70° and 80° F.; tropical currents passed over its surface; deposits of both terrigenous and organic origin accumulated on it in thickness ranging from 100 to 200 feet near the northern shore, to over 1,000 feet near its southern margin. As the water was shallow, the sea bottom must have been gradually depressed while the material accumulating on its surface was being deposited.

At the close of Vicksburgian time the plateau was elevated and areas of its surface were subjected to subaerial denudation, as is attested by the erosion unconformity along the contact of the basal Apalachicola with the underlying Vicksburg sediments.

Apalachicolan time needs separation into two stages: an earlier, represented by the Chattahoochee, Hawthorne and Tampa formations; and a later, represented by the Alum Bluff formation.

The areal extent of the deposits of the earlier stage was not so great as that of the Vicksburg deposits, indicating the later was not so extensive as the previous submergence. The northern shore-line was seaward of that of the Vicksburg Group, it seems probable that a small island may have existed in the sea in what is now the northeastern corner of Marion County, and in other areas the sedimentation over the Vicksburg deposits was thin. Along the western coast of Florida the Vicksburg formations were being gently folded, and a dome-like structure was developing southward. The plateau had practically the same outline as at present; the depth of water north of Tampa was probably in no place over 100 feet. Coral reefs were present in southern Georgia, across the base of the present peninsula, and around Tampa; the temperature was tropical, the minimum for the year being at least as high as 70° F.; the main movement of the ocean water was from the tropics; the sediments consisted to a lesser degree of organic débris, predominantly of terrigenous constituents.

In the later stage of Apalachicolan sedimentation, the island of Oligocene lying west of the present longitudinal axis of the peninsula, had by further uplift increased in size, and was separated from the mainland to the north by the Suwanee Strait. There was differential earth movement, the sea bottom being depressed around the island and between it and the shore of the mainland to the north, permitting additions to the thicknesses of Apalachicola sediments. During this later stage of the Apalachicola, the oceanic waters of the region gradually cooled, and coral reefs disappeared. The sediments were mostly of terrigenous origin and were laid down in shallow water.

This period of deposition was succeeded by one of uplift and subaerial erosion, the Apa-

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lachicolan-Miocene Interval. After this followed the Miocene subsidence. The Miocene subsidence was not so extensive as that of the preceding deposition period, and although it seems probable, it is not positively proved, that the Suwanee Strait was again open water. The Miocene deposits did not extend so far inland as the margin of the Apalachicolan sea, and there were extensive land areas west of the present longitudinal axis of the peninsula. The plateau had approximately its present outline, and thick deposits of arenaceous sands were formed practically to its southern limits, positively as far south as the locality of Key Vaca. The sea was shallow (perhaps 25 fathoms is a safe maximum), there was depression coincident with deposition on the east coast; the waters were cool, a cold inshore counter-current lowering the temperature to that at present prevalent in the region between Cape Hatteras and Long Island. This southward moving counter-current, aided by the winds and the tides, is largely responsible for the greater thickness of sediments on the east than on the west coast, and it is the forerunner of the series of counter-currents so important in the later history of the region. Toward the close of the Miocene period uplift was again initiated, and the Suwanee Strait, should it not have been previously closed, was then assuredly above sea-level, and the north and south Trail Ridge was formed. The uplift seems to have been greater on the east than on the west, for no Miocene is above sea-level from Levy to Pasco counties on the west coast, while submerged Miocene is apparently present off the mouth of Tampa Bay.

The Pliocene submergence was extensive, over half of the present land surface of the peninsula lying below sea-level. The submergence of the present land surface extended down the west side of St. Johns River valley along the east coast, and entirely across the median portion of the peninsula northwest of Lake Istokpoga. No known marine Pliocene occurs on the west coast north of the Charlotte Harbor localities. The general outline of the plateau remained as it was in Miocene time; the water was shallow, usually between 20 and 30 feet in depth; the temperature was tropical in the southern, Caloosahatchee area; and warm, but slightly cooler, in the northeastern area in the vicinity of Nashua. The oceanic currents over the Pliocene bank must have been a warm counter-current—a counter-current because sands were brought from the north and deposited on the Pliocene submarine bank.

While Pliocene marine deposition was taking place, important lacustrine and fluvial deposits were accumulating on the land surface above the sea.

Pliocene deposition was closed by another uplift of the plateau. Data for a precise estimate of the height of the land during this emergence are not available, but the evidence obtainable indicates that it was not over 200 or 250 feet as a maximum, and as the previous movements of the plateau were differential it is most probable that only portions were subjected to oscillations so great. Accompanying this oscillation a shallow syncline was developed along the axis now occupied by the Kissimmee River, with low anticlines on each side. Probably a third anticline was developed west of Peace Creek. The axes of these folds are parallel to the longitudinal axis of the peninsula, and have been important in influencing the drainage courses of middle Florida.

The Pleistocene submergence was as extensive as that of the Pliocene—all Pliocene areas, perhaps, but not probably, excepting one between St. Johns River and the east coast, being resubmerged, and there is a border of Pleistocene on the west coast and the western extension where Pliocene is not now known. The plateau during Pleistocene time preserved its general outline. Shallow water conditions prevailed over its entire submerged portion, in no place were the known deposits laid down in water much deeper than 50 feet, and usually from barely below sea-level to 25 or 30 feet. The temperature north of the latitude of the southern end of Lake Okeechobee was slightly cooler than in Pliocene time, but it was still warm. In this shallow, warm sea sediments of diverse kinds were deposited. Sands and shell marls are probably the most extensive, forming wide-spread deposits over

practically the entire submarine bank. The sands extend beneath the limestone formations as far south as Miami, and perhaps to the southern keys. Along the more northerly portions of the bank coquina accumulated; along a curve, first southward and then bending westward, from Biscayne Bay, a coral reef flourished, separated by a channel of deeper water from the main bank, on which the Miami oolite was forming or had formed in shoal water, strongly agitated by currents. Along the southwestern portion of this bank, also in shoal water, the Lostmans River limestone accumulated. West of the coral reef, on an extensive flat in shoal water, the Key West oolite was formed. Toward the close of the Pleistocene the previously formed sands, marls and limestones southward beyond Miami received a thin coating of siliceous sand. Contemporaneous with this purely marine work, the terracing of rivers to the north was taking place.

Pleistocene time was closed by an uplift, which may have been intermittent, or may have been accompanied by oscillations. There is some evidence of slight depression since the principal uplift. After this uplift the living coral reefs developed, the Everglades were formed, and the Florida of to-day was the result.

Deformation.—The Floridian Plateau owes its origin to a fold of the sea-floor in pre-Oligocene, probably Eocene, time, producing a platform on which sediments during the later geologic periods were laid down. The whole earth mass, since the origin of the platform, has been subjected to a succession of deformations due to compression between forces acting from the east and west, resulting in the axes of the gentle folds coinciding in direction with the longitudinal axis of the plateau. An uplift with deformation took place, as nearly as can be determined, toward the close of the Vicksburgian deposition period. The Vicksburgian nucleus lay nearer to the eastern than the western margin of the plateau, and was roughly dome-like in form, but with a longer north and south than an east and west axis. The subsequent growth of the peninsula was by filling the channel between the island of older Oligocene (Vicksburgian) rocks and the mainland, and by growth eastward and southward from it. There was little or no westward growth. There was additional deformation in later Oligocene (Apalachicolan) time, between the Apalachicolan and Miocene deposition periods, between the Miocene and Pliocene, between Pliocene and Pleistocene, and succeeding the Pleistocene deposition. The result of each of the series of deformations was to add, beginning with the Miocene-Pliocene number of the series, one or more anticlinal swells with intermediate synclinal depressions to those that preceded, the additions above sea-level always taking place toward the east, and at each elevation the uplifting was propagated southward. The continued effect of all the uplifts was to elevate the eastern portion of the plateau above the western, or there has been elevation on the eastern side of the plateau coincident with stability or even slight depression on the western side.

Currents.—The ocean currents, combined with winds and tides, have been important in shaping the land area of Florida. Before the history of the currents of the region can be thoroughly understood it is necessary to know the history of the Hatteras Axis of North Carolina. The present Florida counter-current seems to be due to the impingement of the Gulf Stream against the Hatteras projection, resulting in a portion of the waters being deflected southward along the coast, instead of continuing their northward journey. The Hatteras Axis has existed as a dividing line between depositional areas apparently since middle Cretaceous time, and it has been either a region of shoal water, or occasionally a land area, since later Eocene time. The Vicksburgian and Apalachicolan seas were both warm, tropical or subtropical in temperature. It is not definitely determinable at present whether the warmth of these waters was due to currents directly from the tropics or to a warm return current produced by the northward flowing Gulf Stream having a portion of its waters diverted southward by impinging

against a salient from the more northerly land area. There is some evidence in favor of the latter view.

In Miocene time it is definitely known that a cold inshore current found its way southward to Florida and westward to Pensacola. This current may be due to the Miocene submergence of the Hatteras area, which sufficiently lowered the sea bottom off Hatteras to permit the Gulf Stream to continue its course unobstructedly northward, at the same time permitting a cold inshore current to move southward. The Miocene southward current, aided by winds and tides, transported quantities of terrigenous material and deposited it on the eastern border of the Floridian Pleateau.

Since Miocene time there have constantly been return currents of warm water (however, not so warm as the Gulf Stream), and they have, aided by the winds and tides, transported terrigenous material which was deposited on the eastward side of the existing land areas, sweeping a portion of it to the southern end of the plateau. These currents were active during Pliocene and Pleistocene times, and are still active to-day.

The shape of the upper surface of the Floridian Plateau, the land area of its eastern side, the arrangement of the geologic formations of successive ages, the directions of the stream courses, and the contour of the present coast line, owe their peculiarities and characteristics to the concomitant operation of the forces producing deformations and to oceanic currents.

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GLACIAL LAKES OF THE CATSKILL VALLEY

THE Hudson lobe of the waning Wisconsin ice sheet blockaded the southeastern embouchure of the Catskill Valley, and sent a blunt "thumb" into this depression, pressing against the northeast front of the Catskills. The highest impounded waters were continuous with Schoharie Valley lakes recognized by Fairchild, by way of the summit col at Franklinton, Schoharie County. Then eastward escapes were apparently found between the ice-margin and the Catskill front, carving three or four sets of roughly parallel channels for eight miles between Hervey Street and Cairo Round Top.[1] The series of falling lakes thus determined have as their lower limit the notch behind the Round Top, at about 600 feet, and to this level may be given the name "Lake Durham." The channelings have caused interesting stream diversions, especially of former Shingle Kill headwaters through this notch into the Kiskatom.

The next escape was east of the Round Top, at Cairo Junction, and southward by a minor body ("Lake Kiskatom") into the gorge of the Kaaterskill at Great Falls, and to Lake Albany near Asbury. This lake, at 350 feet, is marked also by a cobble delta of the Catskill north of Cairo, discovered by W. M. Davis. It may be called "Lake Cairo." The hypo-Cairo channels are east of Vedder Hill, near Leeds, between the steep shale slope and a flanking moraine. A mile south of the hill the waters entered Lake Albany and built a shale-pebble delta now largely submerged under Albany clays. Shortly afterward Lake Albany entered the valley and established a grade-plane of which there are extensive remnants at Leeds depot, the mouth of Potuck Creek and at Sandy Plains north of South Cairo. It is significant that these remnants are of much coarser material than the present lower flood-plains of the Catskill, indicating strong drainage from the north, which apparently came around the east face of the Helderbergs via Clarksville, Lawson Lake, etc., and through the Cabin River and Potuck valleys. Heavy scourings at Result and Urlton, noted by Fairchild, are probably due to these waters, which may have included even Mohawk drainage.

The delta of the Catskill in Lake Albany, associated with this grade-plane, is found in Jefferson and West Catskill, now bisected by the creek. It extends four miles south and has crowded the Hudson to the east, but has merely blockaded, without filling, the valley of the Hans Vosen Kill on its north. In the

[1] See Durham, Coxsackie, Kaaterskill and Catskill topographic sheets.